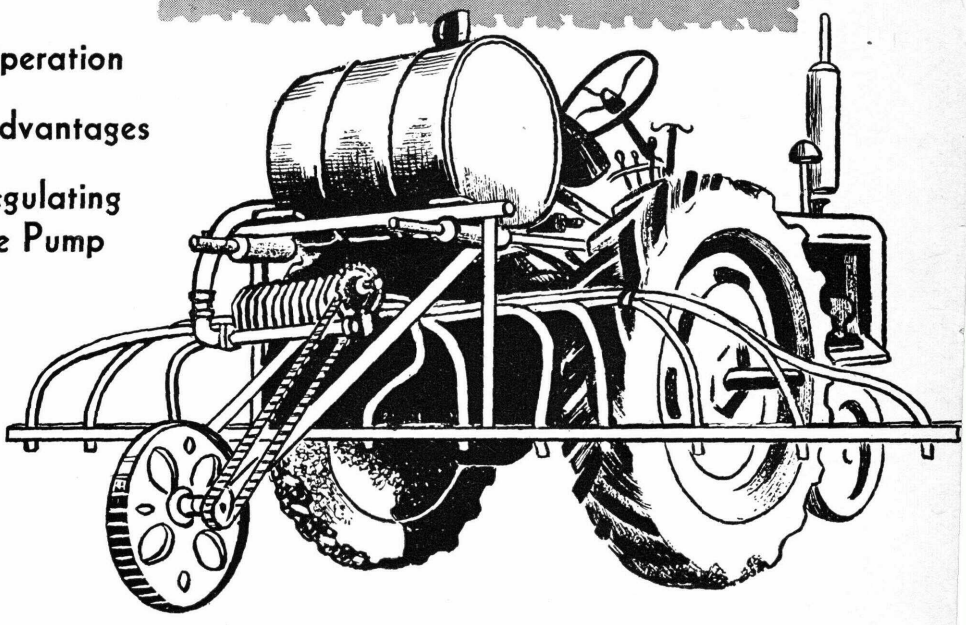
Farmers' Bulletin No. 2096

HOSE PUMP

for applying NITROGEN SOLUTIONS

- Operation
- Advantages
- Regulating the Pump



U. S. DEPARTMENT OF AGRICULTURE

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The hose pump was originally designed and patented by the University of Tennessee in cooperation with the Tennessee Valley Authority. It was modified to improve performance and field tested by the authors. Dale B. Eldredge assisted in construction developments at the Agricultural Engineering Research Laboratory, Beltsville, Md. The Liberty Manufacturing Co., Red Springs, N. C., assisted in field studies.

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HOSE PUMP for applying NITROGEN SOLUTIONS

Liquid nitrogen fertilizers are easier to handle and cost less per unit than dry fertilizers but for the most part only large farm operators have found it economical to purchase and use their own liquid application equipment.

Development of a hose pump that uniformly measures nitrogen solutions [1] makes it possible for more farm operators to own and operate their own equipment and thus take advantage of the saving in cost between liquid and dry fertilizers.

The pump is manufactured in models costing $100 to $200. It weighs less than 25 pounds, and can be mounted easily on a tractor or on a tractor-drawn implement. It can be used for making surface or subsurface applications of nitrogen solutions before or at the time of planting, for applying the solutions as side-dressing or top-dressing, and for applying them to crop residues that are to be plowed under.

A farmer interested in buying and operating nitrogen-solution equipment will want to compare the cost with the cost of custom-application services. To make the comparison he needs to consider how much he would use the equipment each year. Studies in North Carolina indicate that a farmer is justified in investing $100 in nitrogen-solution equipment if he is going to use it each year on 12 acres or more, and $200 if he is going to use it on 22 acres or more.

OPERATION

The pump consists of 1 to 12 or more flexible, plastic-type hoses that are stretched over a 4-roller reel. It is connected to a supply tank by a feed line. The tank must be open or vented during field operation. To assure uniform application, mount the pump so that it is 1 foot or more below the bottom of the tank.

As the reel turns, the rollers move along the hoses. The hoses close when a roller comes in contact with them, and they open again

[1] Nitrogen solutions are nitrogen fertilizers in solution at low pressure. This hose pump is not used to meter high-pressure nitrogen fertilizer (anhydrous ammonia).

after the roller passes. The contact of the rollers with the hoses as the reel turns creates a pumping action that pulls and pushes the solution forward and discharges it at the open ends of the hoses.

When ready to operate, the hoses are stretched over the rollers tightly enough to prevent flow of the fertilizer solution through the hoses unless the reel is turning. When not operating for long periods, the hoses are loosened to prolong their useful life.

For surface application, the hoses can be tied to a homemade boom.

For subsurface application, the hoses can be tied back of cultivator shovels, plows or various types of fertilizer applicator shanks.

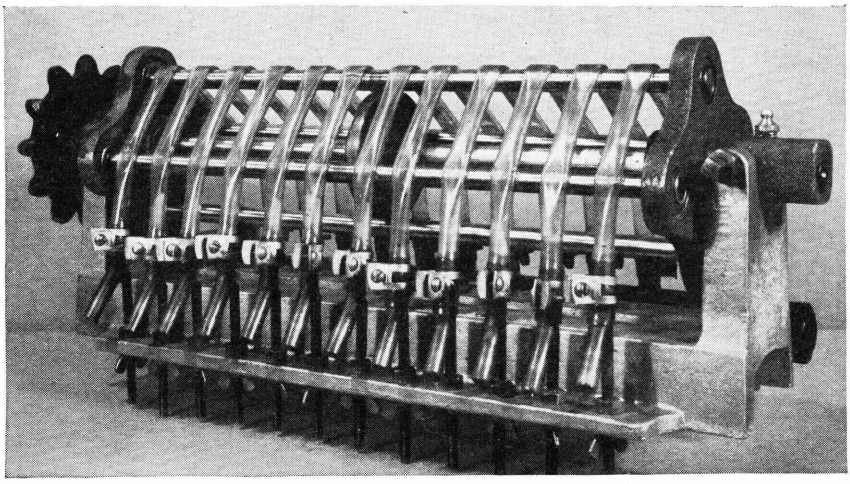
FEATURES

1. One hose pump unit operates as 1 to 12 or more single pumps (depending on the number of hoses) but it costs no more than single pumps of some types.
2. The pump can be driven from a ground wheel because it meters the solution accurately at reel speeds of 50 to 400 revolutions per minute. This makes it possible to apply nitrogen at approximately 20 to 150 pounds per acre.
3. The rate of fertilizer application is constant, at a given setting, regardless of ground speed. This means that all plants get an equal share of the nitrogen regardless of tractor speed.
4. No cut-off valve is required because the flow stops when the reel stops turning.
5. No corrosion can occur because the solutions do not come in contact with any moving parts.
6. The pump requires no by-pass line.
7. No orifices are required in the distribution lines to insure equal distribution to a series of outlets, as required in a pump having a manifold distribution system, because each hose is a separate metering pump.
8. The reel is not damaged if the pump is operated dry after the solutions run out. (The hoses may be damaged if operated dry more than a few minutes.)
9. The desired rate of application can be obtained without trial-and-error runs.
10. The cost of repair and replacement of parts is low. Most farmers will probably find that a set of hoses will last 2 or 3 years. Replacement of a set of 12 hoses costs about $5.

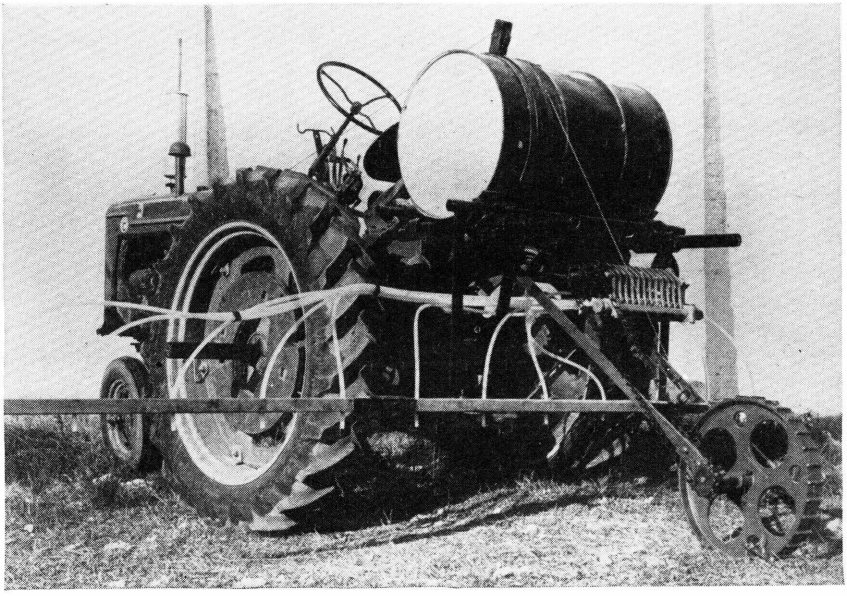
REGULATING THE PUMP

The rate at which the reel turns governs (in a direct ratio) the rate at which nitrogen fertilizer is discharged by each hose on the pump.

The reel is turned by the ground wheel of the equipment on which the pump is mounted. Sprockets on the reel and the ground wheel are connected by a chain drive. The rate at which the reel turns is



Output side of 12-hose pump showing hoses stretched over the reel rollers.



Typical hose pump installation on tractor showing supply tank, pump, hoses tied to boom, and ground wheel.

therefore in direct ratio to the rate at which the ground wheel turns. By varying the ratio you can change the rate at which fertilizer is applied.

To vary the ratio, change the size of the sprockets. This will increase or decrease the number of times the reel turns with each turn of the ground wheel, thereby increasing or decreasing the amount of fertilizer that is discharged through each hose on the pump.

The method you use to determine the size of the sprockets depends on whether the chain drive has 2 sprockets, or 4 sprockets and a counter shaft. A 4-sprocket drive (illustrated on p. 8) permits a more exacting rate of application and a much wider range of rates than a 2-sprocket drive (illustrated on the cover).

Two-Sprocket Chain Drive

If you use a 2-sprocket chain drive, an easy way to vary the ratio between the reel turns and the ground wheel turns is to change the size of the sprocket on the reel. To determine the reel-sprocket size needed for a particular job (1) decide on the per-acre rate at which you want to apply nitrogen, (2) take certain measurements, and (3) make a few simple calculations.

Application Rate

Use the table on page 7 to convert pounds of nitrogen to gallons of nitrogen solution. For example, if you want to apply nitrogen at the rate of 40 pounds (net weight) per acre, the table indicates that you will need to apply the following amounts of nitrogen solution per acre: 17.8 gallons of 21-percent nitrogen, 11.3 gallons of 32-percent nitrogen, 10.9 gallons of 37-percent nitrogen, or 10.3 gallons of 41-percent nitrogen.

Measurements

Following are the measurements needed, and how to take the measurements.

1. The number of times the reel turns to discharge 1 gallon of fertilizer through 1 hose.

Half fill the tank with nitrogen solution. Operate the pump enough to discharge 1 pint into a container that is held under 1 hose. Count the number of reel turns required to fill the container and multiply by 8, the number of pints in a gallon.

2. The width of the field strip to be treated by 1 hose.

Measure the width of a row in the field. Use this measurement in your calculations if 1 hose is to treat 1 row. If 1 hose is to treat 2 rows, multiply the row width by 2; if 2 hoses are to treat 1 row, divide the row width by 2. If the hoses are tied to an applicator boom, use the measured distance between hoses.

3. The circumference of the ground wheel.

Rates of nitrogen per acre converted to gallons

Actual nitrogen per acre (pounds)	Corresponding number of gallons of different solutions			
	21-percent nitrogen	32-percent nitrogen	37-percent nitrogen	41-percent nitrogen
	Gallons	*Gallons*	*Gallons*	*Gallons*
20	8. 9	5. 6	5. 5	5. 1
25	11. 1	7. 1	6. 8	6. 4
30	13. 3	8. 5	8. 2	7. 7
35	15. 6	9. 9	9. 5	9. 0
40	17. 8	11. 3	10. 9	10. 3
45	20. 0	12. 7	12. 3	11. 5
50	22. 2	14. 1	13. 6	12. 8
55	24. 4	15. 5	15. 0	14. 1
60	26. 7	16. 5	16. 4	15. 4
65	28. 9	18. 4	17. 7	16. 7
70	31. 1	19. 8	19. 1	17. 9
75	33. 3	21. 2	20. 4	19. 2
80	35. 6	22. 6	21. 8	20. 5
85	37. 8	24. 0	23. 2	21. 8
90	40. 0	25. 4	24. 5	23. 1
95	42. 2	26. 8	25. 9	24. 4
100	44. 4	28. 2	27. 3	25. 6
110	48. 9	31. 1	30. 0	28. 2
120	53. 3	33. 9	32. 7	30. 8
130	57. 8	36. 7	35. 4	33. 3
140	62. 2	39. 6	38. 2	35. 9
150	66. 7	42. 4	40. 9	38. 5
200	88. 9	56. 5	54. 5	51. 3

Measure the distance the equipment travels under field operating conditions in 10 turns of the ground wheel. Divide the distance by 10. An alternate method is to measure the distance from the center of the axle to the ground surface and multiply the distance by 6.28. If you use this method, allow for wheel slippage that will occur under field conditions. Add a 5- to 10-percent estimate for wheel slippage if the ground wheel is power driven (like a tractor wheel), but subtract the slippage estimate if the ground wheel is not power driven.

Calculations

First step.—Multiply the number of gallons of nitrogen solution per acre by the number of reel turns per gallons by the width of the strip (in feet) by the ground wheel circumference (in feet) and divide the product by 43,560.

The calculation will give the ratio between the rate at which the reel turns and the rate at which the ground wheel turns.

Example:

(1) Your application rate is 40 pounds (net weight) per acre of 41-percent nitrogen solution. The table shows that this rate requires an application of 10.3 gallons per acre.

(2) The reel turns 50 times to discharge 1 pint from 1 hose. Fifty multiplied by 8 is 400—the number of reel turns to discharge 1 gallon.

(3) Each hose is to treat 1 row. The row is 42 inches, or 3.5 feet, wide.

(4) The equipment travels 125 feet in 10 wheel turns. The distance divided by 10 is 12.5 feet.

$$\text{Ratio}=\frac{10.3\times400\times3.5\times12.5}{43{,}560}$$

$10.3\times400=4120$

$3.5\times12.5=43.75$

$4120\times43.75=180{,}250$

$180{,}250\div43{,}560=4.14$

The computed ratio is 4.14, which means that the reel turns a little more than 4 times with each turn of the ground wheel.

Second step.—Divide the size of the sprocket on the ground wheel by the computed ratio. This will give the sprocket size for the reel.

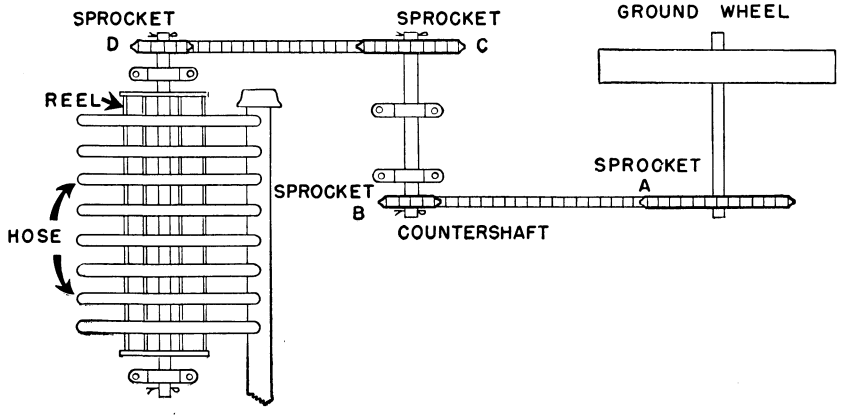
Examples:

(1) The ground wheel has a 24-tooth sprocket. The computed ratio is 4.14. Twenty-four divided by 4.14 is 5.8. Therefore, use a 6-tooth sprocket (the nearest size) on the reel.

(2) The ground wheel has a 32-tooth sprocket. The computed ratio is 4.14. Thirty-two divided by 4.14 is 7.7. Therefore, use an 8-tooth sprocket (the nearest size) on the reel.

Four-Sprocket Chain Drive

If you use a 4-sprocket chain drive similar to the one shown in the accompanying drawing, vary the ratio between the reel turns and the



ground wheel turns by changing the size of sprockets B, C, and D. Leave sprocket A, the drive sprocket on the ground wheel, in place.

Determine the size of sprockets B, C, and D in the same way that you determine the size of the reel sprocket in a 2-sprocket chain drive, but add one item to the first step of the calculations.

Calculations

First step.—Multiply the number of gallons of nitrogen solution per acre by the number of reel turns per gallon by the width of the strip (in feet) by the ground wheel circumference (in feet) and divide the product by the size of the drive sprocket on the ground wheel multiplied by 43,560.

Example:

(1) The application rate and the measurements are the same as those in the first example on page 8.

(2) The ground wheel has a 24-tooth sprocket (sprocket A).

$$\text{Ratio} = \frac{10.3 \times 400 \times 3.5 \times 12.5}{24 \times 43{,}560}$$

$10.3 \times 400 = 4120$
$3.5 \times 12.5 = 43.75$
$4120 \times 43.75 = 180{,}250$
$24 \times 43{,}560 = 1{,}045{,}440$
$180{,}250 \div 1{,}045{,}440 = .1725$

The computed ratio (or, in this example, sprocket factor) of reel turns to ground wheel turns is .1725.

Second step.—Use the table on pages 10 and 11 to determine the size of sprockets B, C, and D. The table gives the size of sprockets to use with various computed ratios ranging from .0417 to .6667.

Example:

The computed ratio is .1725.

The ratio given in the table that is nearest to the computed ratio is .1728 (the first figure at the top of the page in the second column from the right). The other numbers on the same line are the size of sprockets to use. B should be a 9-tooth sprocket, C a 14-tooth sprocket, and D a 9-tooth sprocket.

Other Considerations

You can also change the rate at which nitrogen solutions are applied by changing the number of hoses used, or by changing to hoses that have smaller or larger diameters. (The calculations for determining sprocket sizes, and the tables on pages 7, 10, and 11, will apply regardless of the size of the hoses used.) You can decrease the rate at which nitrogen is applied by diluting the solution with water.

Since the pump should be used with an open tank, you may also want to add water to the low pressure solutions, especially in hot weather, to avoid loss of free ammonia. The addition of water in cold weather will lower the salting-out temperature.

Relationship of computed ratio (R) to size of sprockets B, C, and D

R	B	C	D	R	B	C	D	R	B	C	D	R	B	C	D	R	B	C	D	R	B	C	D
.0417	12	8	16	.0673	8	7	13	.0972	9	14	16	.1327	7	13	14	.1728	9	14	9	.2333	6	14	10
.0420	11	6	13		13	14	16		12	14	12	.1333	6	8	10	.1746	7	11	9	.2344	8	15	8
.0424	11	7	15	.0682	11	9	12	.0982	8	11	14		10	16	12	.1750	8	14	10	.2381	7	15	9
.0429	14	6	10		11	12	16	.0992	11	12	11	.1346	8	14	13	.1758	7	16	13	.2400	10	24	10
	14	9	15	.0688	10	11	16	.1000	8	12	15	.1354	8	13	12	.1778	9	16	10	.2407	6	13	9
.0433	13	9	16	.0694	12	10	12		10	8	8	.1358	9	11	9	.1786	7	10	8	.2424	9	24	11
.0438	10	7	16	.0700	10	7	10	.1016	8	13	16	.1364	8	12	11	.1795	6	14	13	.2449	7	12	7
.0440	13	8	14	.0707	9	7	11	.1026	12	16	13	.1368	9	16	13	.1806	6	13	12	.2500	7	14	8
.0446	14	10	16	.0710	13	12	13	.1037	9	14	15	.1375	8	11	10	.1818	8	16	11		8	16	8
.0449	12	7	13	.0718	13	14	15	.1042	8	10	12	.1389	6	10	12	.1833	6	11	10	.2540	7	16	9
.0455	11	7	14	.0721	13	15	16	.1058	8	11	13	.1400	10	14	10	.1837	7	9	7	.2593	6	14	9
	11	8	16	.0729	8	7	12	.1067	10	16	15	.1414	9	14	11	.1846	10	24	13	.2619	6	11	7
.0458	10	11	24		16	14	12	.1071	8	12	14	.1420	13	24	13	.1852	9	10	6	.2637	7	24	13
	15	11	16	.0733	10	11	15	.1074	11	13	11	.1429	7	8	8		9	15	9	.2653	7	13	7
.0462	13	9	15	.0741	9	8	12	.1083	8	13	15		8	16	14	.1857	7	13	10	.2667	9	24	10
.0467	10	7	15	.0750	10	12	16		10	13	12	.1442	8	15	13	.1875	6	9	8	.2679	8	15	7
.0469	16	9	12	.0764	9	11	16	.1094	8	14	16	.1444	9	13	10		8	12	8	.2708	6	13	8
	16	12	16	.0774	12	13	14	.1100	10	11	10	.1455	10	16	11	.1905	6	8	7	.2727	8	24	11
.0473	13	8	13	.0778	9	7	10	.1111	9	8	8	.1458	12	14	8		6	16	14	.2778	6	15	9
.0476	12	8	14		12	14	15		12	16	12	.1477	8	13	11	.1923	6	15	13	.2857	7	14	7
.0481	13	10	16	.0788	11	13	15	.1122	7	11	14	.1481	9	16	12	.1944	6	14	12		7	16	8
.0485	11	8	15	.0795	8	7	11	.1125	8	9	10	.1500	8	12	10	.1948	7	15	11	.2917	6	14	8
.0486	9	7	16		11	14	16	.1136	8	10	11	.1515	9	15	11	.1964	7	11	8	.2963	9	24	9
	12	7	12		16	14	11	.1143	10	16	14		11	10	6	.1970	6	13	11	.3000	8	24	10
.0491	14	11	16	.0800	10	8	10	.1154	13	12	8	.1524	7	16	15	.1975	9	16	9	.3056	6	11	6
.0495	13	9	14	.0813	10	13	16	.1167	10	14	12	.1528	8	11	9	.1983	11	24	11	.3061	7	15	7

.0500	10	8	16	.0818	10	9	11	.1172	8	15	16	.1531	7	15	14	.2000	6	12	10	.3077	6	24	13
.0510	14	10	14	.0833	6	8	16	.1182	10	13	11	.1538	8	16	13		8	16	10	.3095	6	13	7
.0521	12	10	16		8	10	15	.1190	7	10	12	.1548	6	13	14	.2031	8	13	8	.3117	7	24	11
.0530	11	7	12	.0844	11	13	14		14	10	6	.1556	9	14	10	.2041	7	10	7	.3125	6	15	8
.0536	14	12	16	.0855	9	10	13	.1200	10	12	10	.1563	8	10	8	.2051	6	16	13	.3265	7	16	7
.0545	11	9	15	.0864	9	7	9	.1209	7	11	13	.1571	7	11	10	.2063	7	13	9	.3333	6	14	7
.0556	12	8	12	.0867	10	13	15	.1212	6	8	11	.1587	7	10	9	.2078	7	16	11		6	16	8
.0563	10	9	16	.0875	10	14	16		9	12	11	.1591	8	14	11	.2083	8	15	9	.3429	7	24	10
.0571	10	8	14	.0888	13	15	13	.1224	7	12	14	.1600	10	16	10	.2121	6	14	11	.3571	6	15	7
.0583	15	14	16	.0889	9	8	10	.1235	9	10	9	.1607	7	9	8	.2143	7	12	8	.3611	6	13	6
.0595	14	10	12	.0893	8	10	14	.1250	6	12	16	.1616	9	16	11	.2167	6	13	10	.3636	6	24	11
.0600	10	6	10	.0900	10	9	10		8	10	10	.1625	8	13	10	.2182	10	24	11	.3750	8	24	8
	10	9	15	.0909	11	8	8	.1270	7	8	9	.1633	7	8	7	.2188	8	14	8	.3810	6	16	7
.0612	14	12	14	.0917	10	11	12	.1273	10	14	11		7	16	14	.2222	6	8	6	.3889	6	14	6
.0615	10	8	13	.0926	9	10	12	.1282	6	10	13	.1648	7	15	13		6	16	12	.4000	6	24	10
.0625	12	6	8	.0933	10	14	15	.1286	7	9	10	.1667	6	8	8		9	16	8	.4167	6	15	6
	16	8	8	.0938	8	12	16	.1296	9	14	12		8	16	12	.2245	7	11	7	.4286	7	24	8
.0635	9	8	14	.0947	13	16	13	.1299	7	10	11	.1678	11	24	13	.2273	6	15	11	.4444	6	16	6
.0641	12	10	13	.0952	6	8	14	.1300	10	13	10	.1688	7	13	11	.2286	7	16	10	.4898	7	24	7
.0649	11	10	14		12	16	14	.1313	9	13	11	.1705	8	15	11	.2292	6	11	8	.5000	6	24	8
.0655	12	11	14	.0963	9	13	15	.1319	7	12	13	.1714	7	12	10	.2308	8	24	13	.5714	6	24	7
.0667	10	8	12	.0972	6	7	12	.1322	11	16	11	.1719	8	11	8	.2321	7	13	8	.6667	6	24	6

PREVENT FARM FIRES

Fires kill more than 3,000 farm people each year, and cause painful injury to many thousands more.

In farm homes fire is the main cause of death and injury among younger people.

Each year fires destroy $133,000,000 worth of farm property.

Much of this loss and suffering can be avoided by taking precautions to prevent fires or by being prepared to control those that do get started. In making a fire-safety check on your own farm, keep in mind that the primary causes of farm fires are—

- Lightning
- Sparks on the roof
- Defective chimneys or heating systems
- Faulty electric wiring or appliances
- Careless smokers
- Careless use or storage of gasoline, kerosene, oily rags, and such
- Children playing with matches

Don't start any fire unless you know you can stop it.

Keep a fire extinguisher handy and make sure every member of the family knows how to use it.

For details, see U. S. Department of Agriculture Farmers' Bulletin No. 1643, Fire Safeguards for the Farm.

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